entertaining by the copious illustrations and interesting through the many novel points which are touched upon. As an example of the latter, the question is raised as to the physiological limits of the rapidity of effective response in fencing and boxing, and experiments are cited bearing on this point.

A more serious, and at the present moment more important, aspect of the subject-matter is that which deals with body movements in relation to the improvement of general bodily physique. These are dealt with in the same comprehensive manner as those just referred to, for the author includes most of the gymnastic exercises used in France, Swedish drill, the use of clubs and of apparatus of different kinds.

The malformation of the body is also referred to, whether due to the under-development or to the over-development of special muscular groups; as an example of the first, the malformation of the chest through the weakness of the trunk muscles, abdominal muscles, &c., is conspicuously shown; as an example of over-development, the malformation of the thigh in fencing masters.

The closing chapters are devoted to the conditions which may be presumed to determine how muscular force can be most economically directed towards the production of body movements. The author realises that it would be undesirable in a treatise of a semi-popular character to present this extremely important subject in detail; nor, indeed, can it be set forth in a very convincing manner, since several questions of a fundamental type are still from the scientific point of view in an unsettled state. Thus it is still a matter of doubt how closely the heat-producing properties of muscle are associated with those of mechanical tension or change of form. M. Demeny is well aware of this, and warns his readers that it is impossible to deduce the energy relationships of the animal mechanism from those of artificially constructed machines. In this as in other departments of physiology the hope of arriving at a more precise intellectual standpoint is that expressed by one of Bacon's aphorisms; it will "only be well founded when numerous experiments shall be received and collected into natural history which, though of no use in themselves, assist materially in the discovery of causes and axioms."

In this spirit the various experiments detailed in the concluding chapter of the book must be approached. Most of these are concerned with the influence of walking with definite loads for definite distances; the points noted were the number of steps per minute, the length of the stride, and the posture of the body. It appears that when, as in walking, muscular movements are repeated many times, then there is an optimum rhythm which, by permitting appropriate reparation, allows the maximum of effect with least expenditure of muscular power. The author considers this to be the case in almost all body movements, although experiments are not given in support of this generalisation.

The book as a whole is likely to prove of very considerable value in connection with the subject of physical degeneration, which has been for some time agitating the mind of the public. Methods of education it is now realised should, from the hygienic point of view, concern themselves with the posture of the body. In the code for 1905 issued by the Education Department stress is laid upon the importance of "the careful cultivation of a correct posture at writing and other lessons." This tardy awakening of the authorities to the importance of cultivating the bodily physique of the children who are taught in the national schools renders it probable that teachers will desire to instruct themselves in the fundamental scientific aspects of the various methods for improving the bodily structure and functions. In this respect a work such as that now under review is likely to prove of very real service; it is trustworthy, it approaches the whole question of body posture from a point of view at once scientific and utilitarian, it attacks the fundamental question (that, namely, of the effective action of the muscles), and finally, it is written in a style which makes the subject-matter intelligible without presupposing special technical knowledge on the part of the reader. The only drawback to its utility is one which is susceptible of removal by its translation into English.

F. G.

GEOMETRY OF POSITION.

On the Traversing of Geometrical Figures. By J. Cook Wilson. Pp. x+154. (Oxford: Clarendon Press, 1905.) Price 6*s*. net.

SUPPOSE that an outline figure of any kind is drawn upon a blackboard. In its construction the chalk describes a certain number of closed or open paths, a path being defined as the mark made by the chalk during the whole time of any one of its contacts with the board. But the number of paths thus actually described is not necessarily the smallest by which the figure can be produced, and it is an interesting problem to analyse a given figure into its minimum number of paths, each traversed once. As a simple example, let two oval paths be drawn intersecting in four points; the resulting figure can be traversed as one closed path. If two of the intersections are joined, the new figure can be traversed as one open path; if the remaining intersections are joined, the figure cannot be reduced to less than two paths.

The first two parts of Mr. Wilson's book deal with the problem above stated and various associated questions. The most interesting result is one of greater generality than might have been expected. Let a point in the figure be called odd or even according as an odd or even number of lines radiate from it; then a figure with $2n$ odd points can be analysed into n paths, but no fewer. (To include the case when $n=0$ a slightly modified statement is necessary, which will be found in the book.)

In part iii. the author enters upon new ground by applying the principle of duality; this is the most novel part of the book, and a few comments on it may not be superfluous. The results of the first two parts may, of course, be directly reciprocated without introducing any metrical considerations; but this is

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not what Mr. Wilson does, and the consequences of his procedure are very instructive, especially from the point of view of absolute geometry. He practically confines himself to rectilineal figures, and reciprocates segments into angles, thus introducing metrical elements, and becoming necessarily faced by the complications which they involve. It is now familiar to pure mathematicians that, with an "absolute" conic to define our metrical system, there is a consistent and reciprocal definition of *angle* and *segment* (or *distance* of two points) by which each of these is the product of a constant and the logarithm of a cross-ratio. But to identify these with the expressions for angle and segment obtained by elementary methods with rectangular coordinates it is necessary to suppose the absolute conic to degenerate into one which, considered as a point-locus, is the line at infinity counted twice, and considered as an envelope is the pair of circular points at infinity. This complicated character of the absolute is at the base of all the puzzling difficulties which beset such attempts as this of Mr. Wilson's—difficulties, it is true, which he often surmounts in an ingenious manner.

For example, in the appendix he introduces a system of angular coordinates, both for lines and points, and obtains point and line equations for the ellipse. Now the unmistakable drift of his thought is that if point and line can be defined by coordinates which measure segments, then "reciprocally" line and point can be determined by coordinates which measure angles. But his angular coordinates are not really reciprocal to the segmental coordinates, as is clear from the fact that his equation of the ellipse is trigonometrical and not algebraical. It might be interesting to decide whether any simple functions of Mr. Wilson's angular coordinates are the direct reciprocals of the ordinary Cartesian segmental coordinates.

A remark should also be made on the note (pp. 120–6) on the most general form of the construction of reciprocal figures, as it may prevent possible misunderstanding. In the ordinary process of reciprocation with an auxiliary conic, F and F′ being the corresponding figures, we may say that F′ is derived from F by a process, or rule, of polarising, and that F is derived from F′ by the same rule. Mr. Wilson gives an example in which F′ is derived from F by one process, and F from F′ by another—F and F′ being reciprocal in the general sense of projective geometry. He adds that this is "wider than the usual method," which, of course, it is, if "the usual method" means employing an auxiliary conic. But the figures obtained by his method can be constructed each from the other by the general method of making four points (or lines) in F correspond at pleasure to four lines (or points) in F′, and then to every linear way of constructing F′ from F there is a dualistically corresponding way of deriving F from F′. So that it must not be supposed that Mr. Wilson has discovered any essentially new way of constructing reciprocal figures, though his remark might be misunderstood in that sense.

To return to the more popular aspect of this interesting book. The figures are, strictly, strips of black on a white ground. For the author they represent geometrical lines, and are reasoned upon as such. But the reader may give them different interpretations, and make up problems for himself accordingly. For example, let the lines in a diagram represent cuts made in a single piece of wood by a fret-saw; how many pieces are produced? What is the simplest wire model that will give a shadow like a given diagram? and so on. Stencilling, again, is full of problems analogous to those which Mr. Wilson discusses; knitting and netting give any number of examples of single-path figures. The proverb that "extremes meet" is curiously illustrated by these purely topographical questions, which suggest puzzles for children, problems for designers, and tools for logicians; while they appear with startling unexpectedness in the most abstruse mathematical theories—Abelian functions, group-theory, hydrodynamics, and electricity. G. B. M.

ORGANIC PREPARATIONS AND THE COAL-TAR COLOUR INDUSTRY.

The Synthetic Dyestuffs and the Intermediate Products from which they are derived. By J. C. Cain and J. F. Thorpe. Pp. xiv+405. (London: Chas. Griffin and Co., Ltd., 1905.) Price 16*s.* net.

THE publication of this work is not without significance in its bearing on the oft-repeated statement that the great industry represented by the manufacture of coal-tar dyes is decaying almost to vanishing point in this country. The fact of publication presumes a demand which, in this case, must be mainly confined to those connected with, or training for, the manufacture referred to. It is unlikely that any great number of students in the colleges of this country are preparing for positions in colour works abroad, and it is therefore reasonable to assume that those concerned with the production of the book have satisfied themselves that the industry is not in such a parlous state as pessimists would have us believe. In any event, the book will powerfully influence one factor in the case—the proper instruction of students who are training for the industry.

Whether this touches the root of the matter is, however, doubtful. The gradual decline in importance of the manufacture of coal-tar products in this country has been variously ascribed to the deficient training given in the colleges, the bad patent laws, and the cost of alcohol, relatively to the conditions existing in Germany with regard to these matters. Concerning the work of the colleges, it is now generally conceded that the best of our schools of organic chemistry need fear no comparison with those abroad. The effect of our patent laws, both past and present, in handicapping the industry, has doubtless been very great; but possibly the inquiry of a Royal Commission, such as recently reported into the question of industrial alcohol, would show that, as has been conclusively proved with regard to the cost of alcohol, the effect of the patent laws on the non-

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